

## FOREWORD

### Purpose

This manual was prepared by the Division of Design for Project Delivery. The manual establishes uniform policies and procedures to carry out the highway design functions of the California Department of Transportation (Department). It is neither intended as, nor does it establish, a legal standard for these functions.

The policies established herein are for the information and guidance of the officers and employees of the Department.

Many of the instructions given herein are subject to amendment as conditions and experience seem to warrant. Special situations may call for variation from policies and procedures, subject to Division of Design approval, or such other approval as may be specifically provided for in the text.

It is not intended that any standard of conduct or duty toward the public shall be created or imposed by the publication of the manual. Statements as to the duties and responsibilities of any given classification of officers or employees mentioned herein refer solely to duties or responsibilities owed by these in such classification to their superiors. However, in their official contacts, each employee should recognize the necessity for good relations with the public.

### Scope

This manual is not a textbook or a substitute for engineering knowledge, experience, or judgment. It includes techniques as well as graphs and tables not ordinarily found in textbooks. These are intended as aids in the quick solutions of field and office problems. Except for new developments, no attempt is made to detail basic engineering techniques; for these, standard textbooks should be used.

### Form

The loose-leaf form was chosen because it facilitates change and expansion. New instructions will be issued as sheets in the format of this manual; these

may consist of additional sheets or new sheets to be substituted for those superseded.

### Organization of the Manual

A decimal numbering system is used which permits identification by chapter, topic, and index, each of which is a subdivision of the preceding classification. For example:

Chapter 20 Federal-aid

Topic 42 Federal-aid System

Index 42.2 Interstate

The upper corner of each page shows the page number and the date of issue.

### Use the Table of Contents

The Table of Contents gives the index number and page number for each topical paragraph together with corresponding dates of issue. The holder of the manual should insert the title and the appropriate dates of new instructions as they are received. Revised Table of Contents will be issued as the need arises.

### Use of the English and Metric Editions of the Highway Design Manual

This Sixth Edition of the Highway Design Manual is in U.S. Customary (English) units. All projects designed and constructed in English units shall follow the standards in this manual per the instructions contained in Index 82.5, "Effective Date for Implementing Revisions to Design Standards".

The Metric standards contained in the Fifth Edition of the Highway Design Manual, and related publications, are to continue to be used if the specific project was granted an exception to be delivered in Metric units. See Department memorandum dated June 16, 2006, signed by Richard D. Land, entitled "Declaration of Units of Measure – "Metric" or "English" Project."

## Metric Basics

Measurable Attribute - Basic Units		Unit	Expression
Length		meter	m
Mass		kilogram	kg
Luminous intensity		candela	cd
Time		second	s
Time		hour	h
Electric current		ampere	A
Thermodynamic temperature		Kelvin	K
Amount of substance		mole	mol
Volume of liquid		liter	L
Measurable Attribute - Special Names		Unit	Expression
Frequency of a periodic phenomenon		hertz	Hz (1/s)
Force		newton	N (kg·m/s <sup>2</sup> )
Energy/work/quantity of heat		joule	J(N·m)
Power		watt	W (J/s)
Pressure/stress		pascal	Pa (N/m <sup>2</sup> )
Celsius temperature		Celsius	°C
Quantity of electricity/electrical charge		coulomb	C
Electric potential		volt	V
Electric resistance		ohm	Ω
Luminous flux		lumen	lm
Luminance		lux	lx (lm/m <sup>2</sup> ) or (cd/m <sup>2</sup> )
Measurable Attribute - Derived Units		Unit	Expression
Acceleration		meter per second squared	m/s <sup>2</sup>
Area		square meter	m <sup>2</sup>
Area		hectare	ha (10 000 m <sup>2</sup> )
Density/mass		kilogram per cubic meter	kg/m <sup>3</sup>
Volume		cubic meters	m <sup>3</sup>
Velocity		meter per second	m/s
Mass		tonne	tonne (1000 kg)
Multiplication Factors	Prefix	Symbol	Pronunciations
1 000 000 000 = 10 <sup>9</sup>	giga	G	jig' a ( <i>i</i> as in <i>jig</i> , <i>a</i> as in <i>a-bout</i> )
1 000 000 = 10 <sup>6</sup>	mega	M	as in <i>mega</i> -phone
1000 = 10 <sup>3</sup>	kilo	k	kill' oh
100 = 10 <sup>2</sup>	*hecto	h	heck' toe
10 = 10 <sup>1</sup>	*deko	da	deck' a ( <i>a</i> as in <i>a-bout</i> )
0.1 = 10 <sup>-1</sup>	*deci	d	as in <i>deci</i> -mal
0.01 = 10 <sup>-2</sup>	*centi	c	as in <i>centi</i> -pede
0.001 = 10 <sup>-3</sup>	milli	m	as in <i>mili</i> -tary
0.000 001 = 10 <sup>-6</sup>	micro	μ	as in <i>micro</i> -phone
0.000 000 001 = 10 <sup>-9</sup>	nano	n	nan' oh ( <i>an</i> as in <i>ant</i> )

\* to be avoided where possible

### Common Conversion Factors to Metric

Class	Multiply:	By:	To Get:
Area	ft <sup>2</sup>	0.0929	m <sup>2</sup>
	yd <sup>2</sup>	0.8361	m <sup>2</sup>
	mi <sup>2</sup>	2.590	km <sup>2</sup>
	acre	0.404 69	ha
Length	ft	0.3048	m
	in	25.4	mm
	mi	1.6093	km
	yd	0.9144	m
Volume	ft <sup>3</sup>	0.0283	m <sup>3</sup>
	gal	3.785	L *
	fl oz	29.574	mL *
	yd <sup>3</sup>	0.7646	m <sup>3</sup>
	acre ft	1233.49	m <sup>3</sup>
Mass	oz	28.35	g
	lb	0.4536	kg
	kip (1,000 lb)	0.4536	tonne (1000 kg)
	short ton (2,000 lb)	907.2	kg
	short ton	0.9072	tonne (1000 kg)
Density	lb/yd <sup>3</sup>	0.5933	kg/m <sup>3</sup>
	lb/ft <sup>3</sup>	16.0185	kg/m <sup>3</sup>
Pressure	psi	6894.8	Pa
	ksi	6.8948	MPa (N/mm <sup>2</sup> )
	lb <sub>f</sub> /ft <sup>2</sup>	47.88	Pa
Velocity	ft/s	0.3048	m/s
	mph	0.4470	m/s
	mph	1.6093	km/h
Temp	°F	$t_{°C} = (t_{°F} - 32)/1.8$	°C
Light	footcandle (or) lumen/ft <sup>2</sup>	10.7639	lux (lx) (or) lumen/m <sup>2</sup>

\* Use Capital "L" for liter to eliminate confusion with the numeral "1"

### Land Surveying Conversion Factors

Class	Multiply :	By:	To Get
Area	acre	4046.87261	m <sup>2</sup>
	acre	0.404 69	ha (10 000 m <sup>2</sup> )
Length	ft	1200/3937**	m

\*\* Exact, by definition of the US Survey foot, Section 8810, State of California Public Resources Code